MOBILE COMMUNICATION SYSTEM, RADIO BASE STATION CONTROLLER AND TRANSMITTING AND RECEIVING POWER CONTROL METHOD THEREFOR

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a mobile communication system, a radio base station controller and a transmitting and receiving power control method therefor, and more particularly to a transmitting and receiving power control method in a CDMA (Code Division Multiple Access) system.

Description of the Related Art

Conventionally, in a CDMA radio access system, a number of radio base stations and mobile terminals make the communications by setting up the link at the same frequency, whereby a receiving power (desired wave power) of signal in a certain line may interfere with another line and become an interference wave power. Therefore, in a satellite uplink in which the mobile terminal transmits and the radio base station receives, if a desired wave power exceeds a predetermined value, the interference wave power is increased and the capacity of line is decreased.

In order to solve this problem, in the conventional CDMA radio access system, a method for increasing the capacity of uplink by preventing the use of excessive transmitting power in transmission from the mobile terminal to the radio base station has been offered (e.g., refer to patent document 1).

With this method, the radio base station compares the receiving quality of a transmitting signal from the mobile terminal with the target receiving quality, in which an increased amount of transmitting power at the radio base station is decided based on its comparison result, the increased amount is added to the transmitting power at the radio base station upon a control instruction transmitted from the mobile terminal, and a control instruction for controlling the transmitting power at the mobile terminal is transmitted by the added transmitting power.

[Patent Document 1]

Japanese Patent Laid-Open No. 2001-119342 (pages 19 and 20, FIG. 5)

In the above-mentioned conventional CDMA radio access system, the user is discriminated according to the code at the same frequency, whereby one mobile terminal or radio base station is affected by interference powers from other users, so that the communication quality is deteriorated.

That is, if the high quality communication tries to be made, the transmitting power of the radio base station or mobile terminal is increased, and the interference power is increased at the same time, so that the maximum number of accommodating the mobile terminals at one radio base station is decreased. If the number of accommodating the mobile terminals is increased, the power assigned to each mobile terminal is smaller, resulting in a problem that the communication quality is deteriorated.

SUMMARY OF THE INVENTION

Thus, the invention has been achieved to solve the above-mentioned problems, and it is an object of the invention to provide a mobile communication system, a radio base station controller and a transmitting and receiving power control method therefor, in which the conflicting abilities of making the higher quality communication and keeping the accommodation number of mobile terminals are controlled efficiently.

According to the present invention, there is provided a mobile communication system comprising a radio base station controller for performing at least a radio line control and a resource control for the radio base station, and at least a radio line control, a resource control and a bearer control for a mobile terminal, wherein the radio base station controller comprises control means for controlling a communication quality between the radio base station and the mobile terminal on the basis of the information regarding the amount of interference from the radio base station.

The invention provides a radio base station controller for performing at least a radio line control and a resource control for the radio base station, and at least a radio line control, a resource control and a bearer control for a mobile terminal, wherein the radio base station controller comprises control means for controlling a communication quality between the radio base station and the mobile terminal on the basis of the information regarding the amount of interference from the radio base station.

The invention provides a transmitting and receiving power control method for use in a mobile communication system comprising a radio base station controller for performing at least a radio

line control and a resource control for the radio base station, and at least a radio line control, a resource control and a bearer control for a mobile terminal, the method comprising, on the side of the radio base station controller, a step of controlling a communication quality between the radio base station and the mobile terminal on the basis of the information regarding the amount of interference from the radio base station.

That is, the mobile communication system of the invention employs a radio access method in the CDMA (Code Division Multiple Access) system. In this CDMA system, the user is discriminated according to the code at the same frequency, whereby one mobile terminal or radio base station is affected by interference powers from other users. Under the influence of the interference powers, the maximum number of users that can be accommodated in the radio base station is limited to some extent in the CDMA system.

Usually, to increase the maximum number of users, the mobile terminal or radio base station employs a function of Outer Loop control for controlling the transmitting power of the distant party on the basis of the required quality for each communication bearer to enable the communication with the minimum needed receiving power.

Herein, the Outer Loop control constitutes a Closed Loop transmitting power control together with the Inner Loop control. In the Inner Loop control, SIR (Signal-to-Interference power Ratio) on a receiving communication channel is controlled to take a target value, while in the Outer Loop control, the target SIR is controlled so that the communication quality [BER (Bit Error Rate), BLER (Block Error Rate)] may take a target value.

In this case, the communication quality is measured in a longer interval (from several 100 ms to a few seconds) to set the target SIR appropriate to attain the target quality.

In the mobile communication system of the invention, the Outer Loop function is operated adaptively by the interference power or transmitting power at a certain time, whereby it is possible to control efficiently the conflicting system abilities of making the communication at the maximum communication quality when there is a small amount of interference within the radio base station, and keeping the maximum accommodation number by degrading the communication quality when there is a great amount of interference.

Thereby, in the mobile communication system of the invention, the CDMA radio access system provides the control to make the high quality communication by maximizing the bearer required quality of the mobile terminal when the amount of interference is relatively small, and to increase the number of accommodating the users by degrading the bearer required quality to a needed minimum level in the order from the mobile terminal of lower service class during communication when there is a great interference wave due to an increased number of users, whereby the conflicting system abilities of making the high quality communication and keeping the maximum number of accommodating the mobile terminals are controlled efficiently.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing the configuration of a mobile communication system according to one embodiment of the present invention;

FIG. 2 shows a data format flowing on a radio line between a radio base station and a mobile terminal;

FIG. 3 is a sequence chart showing the operation of the mobile communication system according to the embodiment of the invention;

FIG. 4 shows the configuration of a bearer quality management table within a radio base station controller of FIG. 1;

FIG. 5 is a flowchart showing the operation of the radio base station controller of FIG. 1;

FIG. 6 is a sequence chart showing the operation of the mobile communication system according to another embodiment of the invention;

FIG. 7 shows the configuration of a bearer quality management table within the radio base station controller according to another embodiment of the invention;

FIG. 8 is a flowchart showing the operation of the radio base station controller according to another embodiment of the invention;

FIG. 9 is a block diagram showing the operation of a mobile communication system according to another embodiment of the invention;

FIG. 10 is a sequence chart showing the operation of the mobile communication system according to another embodiment of the invention;

FIG. 11 shows the configuration of a bearer quality management table within the radio base station controller of FIG. 9; and

FIG. 12 is a flowchart showing the operation of the radio base station controller of FIG. 9.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiments of the present invention will be described below with reference to the accompanying drawings. FIG. 1 is a block diagram showing the configuration of a mobile communication system according to one embodiment of the invention. In FIG. 1, the mobile communication system according to one embodiment of the invention comprises a radio base station controller 1, a radio base station 2, and a mobile terminal 3.

The radio base station controller 1 comprises a mobile terminal protocol terminator 11 and a radio base station protocol terminator 12. The radio base station 2 comprises a radio quality measuring part 21 and a radio base station protocol terminator 22. The mobile terminal 3 comprises a bearer quality control part 31, a radio quality control part 32 and a mobile terminal protocol terminator 33.

The radio base station controller 1 makes a radio line control and a resource control for the radio base station 2 via the radio base station protocol terminator 12, and makes a radio line control, a resource control and a bearer control for the mobile terminal 3 via the mobile terminal protocol terminator 11.

FIG. 2 is a chart showing a data format flowing on the radio line between the radio base station 2 and the mobile terminal

3 as shown in FIG. 1. Referring to FIGS. 1 and 2, the operation of the mobile communication system according to one embodiment of the invention will be now described.

Herein, while the mobile terminal 3 is communicating via the radio base station 2, the radio base station 2 divides bearer data A into radio blocks of predetermined length (divided bearer data) A1, in which the bearer data A, to which a redundant bit A2 for error detection is added to each radio block, is spreaded using a spreading code for the mobile terminal 3 and transmitted over the radio line.

At the mobile terminal 3, the bearer quality control part 31 detects the presence or absence of a block error for each radio block based on a redundant bit A2 for error detection, and measures the BLER (Block Error Rate) for a certain period. Also, the mobile terminal 3 has a function of requesting the radio base station 2 to increase or decrease the transmitting power, the radio quality measuring part 32 of the mobile terminal 3 requests the radio base station 2 to increase or decrease the transmitting power so as to have a required receiving quality (receiving level).

Moreover, at the mobile terminal 3, the radio quality control part 32 controls the receiving quality (receiving level) so that the bearer quality may be required quality based on the quality of bearer measured by the bearer quality control part 31.

Additionally, the radio base station 2 always monitors the quality for the radio section between the radio base station 2 and the mobile terminal 3. When the radio quality exceeds a threshold value specified beforehand from the radio base station

controller 1, the radio base station 2 reports the radio base station controller 1 via the radio base station protocol terminator 22 with a radio quality report 201 to make the radio quality better or worse.

Furthermore, the mobile terminal 3 has a function of changing the required bearer quality upon a bearer quality change request 202 from the radio base station controller 1 via the mobile terminal protocol terminator 33.

FIG. 3 is a sequence chart showing the operation of the mobile communication system according to one embodiment of the invention, FIG. 4 shows the configuration of a bearer quality management table within the radio base station controller 1 of FIG. 1, and FIG. 5 is a flowchart showing the operation of the radio base station controller 1 of FIG. 1. Referring to FIGS. 1 to 5, the operation of the mobile communication system according to one embodiment of the invention will be described below.

At the bootstrap (a1 in FIG. 3) of radio line performed by the radio base station controller 1, a radio quality report request is made to the radio base station 2 via the radio base station protocol terminator 12, in which a periodical report or a threshold information (Threshold: x, y, z) for reporting when the threshold of the radio quality is exceeded is included (a11 in FIG. 3). The radio base station 2 reports the radio quality report (quality = X) to the radio base station controller 1 in response to the request (a12 in FIG. 3).

When one mobile terminal 3 makes a call via the radio base station 2 (a2 in FIG. 3), first of all, the radio base station controller 1 decides the bearer quality (BLER = 0.0) of the mobile

terminal 3, using the latest radio quality = x from the radio base station 2 and the bearer quality management table B (see FIG. 4) possessed by itself, and transmits a radio line setting request to the radio base station 2 via the radio base station protocol terminator 12 (a21 in FIG. 3), and a radio line setting request to the mobile terminal 3 via the mobile terminal protocol terminator 11 (a22 in FIG. 3). In this state, the mobile terminal 3 makes the stable communication with reception BLER = 0.0 (a23, a24 in FIG. 3).

For example, when the amount of interference is increased due to concentrated accesses from other users while the mobile terminal 3 is communicating (a3 in FIG. 3), and when the radio quality being measured by the radio quality measuring part 21 of the radio base station 2 exceeds Threshold = y, the radio base station 2 issues a radio quality worsening report (report value = y) to the radio base station controller 1 (a31 in FIG. 3). If the radio base station controller 1 receives the radio quality worsening report (step S1 in FIG. 5), it transmits a bearer quality change request (BLER = 0.05) to the mobile terminal 3, using the bearer quality management table B (a32 in FIG. 3) (steps S4, S5 in FIG. 5).

If the mobile terminal 3 receives the bearer quality change request (BLER = 0.05), it resets the bearer quality at BLER = 0.05 (a33 in FIG. 3). Also, the bearer quality control part 3 within the mobile terminal 3 makes a request to the radio quality control part 32 to decrease the required receiving quality. Thereby, the bearer quality is decreased, but the downlink transmitting power of the radio base station 2 is decreased to

reduce the interference, making it possible to increase the number of accommodating the mobile terminals.

Moreover, if the radio quality being measured by the radio quality measuring part 21 of the radio base station 2 exceeds Threshold = z, the radio base station 2 reissues a radio quality worsening report (report value = z) to the radio base station controller 1 (a34 in FIG. 3) (step S1 in FIG. 5). If the radio base station controller 1 receives the radio quality worsening report, it transmits a bearer quality change request (BLER = 0.1) to the mobile terminal 3, using the bearer quality management table B (a35 in FIG. 3) (steps S4, S6 in FIG. 5).

If the mobile terminal 3 receives the bearer quality change request (BLER = 0.1), it resets the bearer quality at BLER = 0.1 (a36 in FIG. 3). Thereby, for the mobile terminal 3, the bearer quality is decreased to BLER = 0.1 and the downlink transmitting power is reduced, whereby the number of accommodating the mobile terminals is increased.

Lastly, when there is less interference from other users and the radio quality being measured by the radio quality measuring part 21 of the radio base station 2 is below Threshold, the radio base station 2 issues a radio quality improvement report (report value = x) to the radio base station controller 1 (a41 in FIG. 3). If the radio base station controller 1 receives the radio quality improvement report (step S1 in FIG. 5), it transmits a bearer quality change request (BLER = 0.0) to the mobile terminal 3, using the bearer quality management table B (a42 in FIG. 3) (steps S2, S3 in FIG. 5).

If the mobile terminal 3 receives the bearer quality change request (BLER = 0.0), it resets the bearer quality at BLER = 0.0 (a43 in FIG. 3). Thereby, the required receiving quality of the mobile terminal 3 is increased (BLER = 0.0), enabling the stable communication again.

In this way, in this embodiment, the CDMA radio access system provides the control to make the high quality communication by maximizing the bearer required quality of the mobile terminal 3 when the amount of interference is relatively small, and to increase the number of accommodating the users by degrading the bearer required quality to the needed minimum from the mobile terminal 3 during communication in the order of lower service class when there is a greater interference wave due to an increased number of users, whereby the conflicting system abilities of making the high quality communication and keeping the maximum number of accommodating the mobile terminals are controlled efficiently.

FIG. 6 is a sequence chart showing the operation of a mobile communication system according to another embodiment of the invention, FIG. 7 shows the configuration of a bearer quality management table within the radio base station controller according to another embodiment of the invention, and FIG. 8 is a flowchart showing the operation of the radio base station controller according to another embodiment of the invention. The system configuration according to another embodiment of the invention is the same as the system configuration according to one embodiment of the invention as shown in FIG. 1. Referring to FIG. 1 and FIGS. 6 to 8, the operation of the mobile communication

system according to another embodiment of the invention will be described below.

Usually, the mobile terminals 3 include the mobile terminal requiring high quality, the mobile terminal emphasizing the connection time even with a middle degree of quality, and are often classified for each service class. Thus, in another embodiment of the invention, as the bearer quality management table provided for the radio base station controller 1, the bearer quality management table B is partitioned into the bearer quality management table C for each service class (see FIG. 7).

For example, when the amount of interference is increased due to concentrated accesses from other users while the mobile terminal is communicating, and when the radio quality being measured by the radio quality measuring part 21 of the radio base station 2 exceeds Threshold = y, the radio base station 2 issues a radio quality worsening report (report value = y) to the radio base station controller 1 (b11 in FIG. 6).

If the radio base station controller 1 receives the radio quality worsening report (step S11 in FIG. 8), it maintains the high quality communication to the mobile terminal having a high service class (service class 1), using the bearer quality management table C by keeping the existent bearer quality (BLER = 0.0) for the radio quality worsening report (report value = y) from the radio base station 2 (b11 in FIG. 6) (steps S15, S16, S18 in FIG. 8).

In this case, if the radio base station controller 1 receives the radio quality worsening report (report value = y) from the radio base station 2, it requests a bearer quality change request

(BLER = 0.05) to the mobile terminal having a low service class (service class 2) (b12 in FIG. 6) (steps S15, S16, S17 in FIG. 8), thereby enabling the minute control in consideration of the service class of the mobile terminal.

If the mobile terminal (service class 2) receives the bearer quality change request (BLER = 0.05), it resets the bearer quality at BLER = 0.05 (b13 in FIG. 6). Also, the bearer quality control part 31 within the mobile terminal (service class 2) makes a request to the radio quality control part 32, to decrease the required receiving quality. Thereby, the bearer quality of the mobile terminal (service class 2) is decreased to BLER = 0.1, but the downlink transmitting power is further decreased, making it possible to increase the number of accommodating the mobile terminals.

Moreover, if the radio quality being measured by the radio quality measuring part 21 of the radio base station 2 exceeds Threshold = z, the radio base station 2 reissues a radio quality worsening report (report value = z) to the radio base station controller 1 (b14 in FIG. 6) (step S11 in FIG. 8).

If the radio base station controller 1 receives the radio quality worsening report, it transmits a bearer quality change request (BLER = 0.05) to the mobile terminal having a high service class (service class 1), using the bearer quality management table C (b15 in FIG. 6) (steps S12, S13, S17 in FIG. 8).

If the mobile terminal (service class 1) receives the bearer quality change request (BLER = 0.05), it resets the bearer quality at BLER = 0.05 (a17 in FIG. 6). Also, the bearer quality control part 31 within the mobile terminal (service class 1) makes a

request to the radio quality control part 32 to decrease the required receiving quality. Thereby, for the mobile terminal (service class 1), the bearer quality is decreased to BLER = 0.05, but the downlink transmitting power by the radio base station 2 is reduced to have less interference, whereby the number of accommodating the mobile terminals is increased.

In this case, if the radio base station controller 1 receives the radio quality worsening report (report value = z) from the radio base station 2, it requests a bearer quality change request (BLER = 0.1) to the mobile terminal having a low service class (service class 2) (b16 in FIG. 6) (steps S12, S13, S14 in FIG. 8), thereby enabling the minute control in consideration of the service class of the mobile terminal.

If the mobile terminal (service class 2) receives the bearer quality change request (BLER = 0.1), it resets the bearer quality at BLER = 0.1 (b18 in FIG. 6). Also, the bearer quality control part 31 within the mobile terminal (service class 2) makes a request to the radio quality control part 32, to decrease the required receiving quality. Thereby, the bearer quality of the mobile terminal (service class 2) is decreased, but the downlink transmitting power by the radio base station 2 is further decreased to have less interference, making it possible to increase the number of accommodating the mobile terminals.

Lastly, when there is less interference from other users and the radio quality being measured by the radio quality measuring part 21 of the radio base station 2 is below Threshold, the radio base station 2 issues a radio quality improvement report (report value = x) to the radio base station controller 1 (b21 in FIG.

6). If the radio base station controller 1 receives the radio quality improvement report (step S11 in FIG. 8), it transmits a bearer quality change request (BLER = 0.0) to all the mobile terminals 3, using the bearer quality management table C (b22, b23 in FIG. 6) (steps S15, S18 in FIG. 8).

If all the mobile terminals receive the bearer quality change request (BLER = 0.0), they reset the bearer quality at BLER = 0.0 (b24, b25 in FIG. 6). Thereby, the required receiving qualities of all the mobile terminals are increased (BLER = 0.0), enabling the stable communication again. As described above, the minute control is enabled in consideration of the service class of the mobile terminal in this embodiment.

FIG. 9 is a block diagram showing the configuration of a mobile communication system according to another embodiment of the invention. In FIG. 9, the mobile communication system according to another embodiment of the invention comprises a radio base station controller 4, a radio base station 5 and a mobile terminal 6.

The radio base station controller 4 comprises a mobile terminal protocol terminator 41, a bearer quality control part 42, and a radio base station protocol terminator 43. The radio base station 5 comprises a radio quality measuring part 51, a radio quality control part 52, and a radio base station protocol terminator 53. The configuration of the mobile terminal 6 is not directly related with the control in this embodiment, and not shown in the figure.

In the mobile communication system according to another embodiment of the invention, the power control with radio quality

or bearer quality is applied to the upline (in a transmission direction from the mobile terminal 6 to the radio base station 5).

FIG. 10 is a sequence chart showing the operation of the mobile communication system according to another embodiment of the invention, FIG. 11 shows a bearer quality management table within the radio base station controller 4 of FIG. 9, and FIG. 12 is a flowchart showing the operation of the radio base station controller 4 of FIG. 9. Referring to FIGS. 9 to 12, the operation of the mobile communication system according to another embodiment of the invention will be described below.

At the bootstrap (c1 in FIG. 10) of radio line performed by the radio base station controller 4, a radio quality report request is made to the radio base station 5 via the radio base station protocol terminator 43, in which the radio quality report request has threshold information (Threshold: xx, yy, zz) for reporting when a periodical report or threshold of the radio quality is exceeded (c11 in FIG. 10). The radio base station 5 reports the radio quality report (quality = xx) to the radio base station controller 4 in response to the request (c12 in FIG. 10).

When one mobile terminal 6 makes a call via the radio base station 5 (c2 in FIG. 10), first of all, the radio base station controller 4 decides the bearer quality (BLER = 0.0) of the mobile terminal 6, using the latest radio quality = xx from the radio base station 5 and the bearer quality management table D (see FIG. 11) possessed by itself, and transmits a radio line setting

request to the radio base station 5 via the radio base station protocol terminator 43 (c2 in FIG. 10).

Also, the radio base station controller 4 transmits a radio line setting request to the mobile terminal 6 via the mobile terminal protocol terminator 41 (c22 in FIG. 10). In this state, the bearer quality control part 42 in the uplink direction within the radio base station controller 4 controls the uplink bearer quality at BLER = 0.0 (c23 in FIG. 10), enabling the stable communication between the mobile terminal 6 and the radio base station 5 (c24 in FIG. 10).

During this communication, when there is a greater amount of interference due to an increased number of users so that the radio quality measured by the radio quality measuring part 51 of the radio base station 5 exceeds Threshold = xx, the radio base station 5 issues a radio quality worsening report (report value = yy) to the radio base station controller 4 (c31 in FIG. 10).

Within the radio base station controller 4, the bearer quality control part 42 changes the quality of the corresponding bearer (BLER = 0.05) (c32 in FIG. 10) (steps S21, S25, S26 in FIG. 12). Moreover, the bearer quality control part 42 transmits a radio quality change request to the radio base station 5 to adapt to the reset bearer quality (c33 in FIG. 10)(step S27 in FIG. 12). The radio quality control part 52 of the radio base station 5 having received the radio quality change request decreases the required radio quality to a specified value.

Moreover, if the radio quality being measured by the radio quality measuring part 51 of the radio base station 5 exceeds

Threshold = zz, the radio base station 5 transmits the radio quality worsening report (report value = zz) to the radio base station controller 4 again (c34 in FIG. 10).

Within the radio base station controller 4, the bearer quality control part 42 changes the quality of the corresponding bearer (BLER = 0.1) (c35 in FIG. 10) (steps S21, S22, S23 in FIG. 12). Moreover, the bearer quality control part 42 transmits a radio quality change request to the radio base station 5 to adapt to the reset bearer quality (c36 in FIG. 10)(step S24 in FIG. 12). The radio quality control part 52 of the radio base station 5 having received the radio quality change request decreases the required radio quality to a specified value.

Lastly, when there is less interference from other users and the radio quality being measured by the radio quality measuring part 51 of the radio base station 5 is below Threshold, the radio base station 5 issues a radio quality improvement report (report value = xx) to the radio base station controller 4 (c41 in FIG. 10).

Within the radio base station controller 4, the bearer quality control part 42 resets the corresponding bearer quality at BLER = 0.0 (c42 in FIG. 10) (steps S21, S25, S28 in FIG. 12). Moreover, the bearer quality control part 42 transmits a radio quality change request to the radio base station 5 to adapt to the reset bearer quality (c43 in FIG. 10)(step S29 in FIG. 12). The radio quality control part 52 of the radio base station 5 having received the radio quality change request increases the required radio quality to a specified value.

Thereby, in this embodiment, the total power received at the radio base station 5 is decreased, so that the total amount of interference is reduced, the number of accommodating the mobile terminals is increased. Since the power control in each of the embodiments of the invention is controlled independently, the communication quality control or communication capacity control is made more efficiently by performing the power control at the same time.

As described above, with this invention, the conflicting abilities of making the high quality communication and keeping the number of accommodating the mobile terminals are controlled efficiently by employing the configuration and operation of the invention.